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ABSTRACT

Although Robert M. Gagne's work is often thought of as learning theory, his contributions can most appropriately be considered as an "instructional theory." This denotes an integrated set of principles based upon learning theory, other relevant theories, and sound replicable research, that permits one to predict the effects of specific instructional conditions on a learner's cognitive processing and the resulting learned capabilities. This paper discusses: (1) the status of instructional theory before Gagne, specifically, curriculum theory and applied learning theory; (2) precursors to instructional theory; (3) instructional theory contributions, including the development of the types of learning, the learning hierarchies concept, events of instruction, and conditions of learning; (4) the relationship of Gagne's work to learning theory; (5) the influences of Gagne's theory on instructional design models; and (6) the influences of Gagne's theory on curriculum design. Gagne's process of developing, refining, and extending his theory over time based upon new research and theory distinguishes him among scholars in the fields of educational psychology and instructional theory. (Contains 93 references.) (SWC)

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Title:

Impact of R.M. Gagné's Work on Instructional Theory

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Although it is not unusual for R.M. Gagné's work to be considered in a volume addressing learning theories, his contributions can most appropriately be considered as an "instructional theory." An instructional theory is an integrated set of principles, based upon learning theory, other relevant theories, and sound replicable research, that permits one to predict the effects of specific instructional conditions on a learner's cognitive processing and the resulting learned capabilities. Gagné (1985) described the nature of an instructional theory as an "attempt to relate the external events of instruction to the outcomes of learning by showing how these events lead to appropriate support or enhancement of internal learning processes. . . The province of an instructional theory is to propose a rationally based relationship between instructionAL events, their effects on learning processes, and the learning outcomes that are produced as a result of these processes." (p. 244) How does instructional theory relate to learning theories, instructional psychology, and instructional design models. In contrast to instructional theories that tend to be predictive and prescriptive, learning theories are typically descriptive and explanatory. According to Driscoll (1994) a learning theory "a set of constructs linking observed changes in performance with what is thought to bring about those changes." (p. 9) Instructional psychology is the study of the facilitation of human learning through instruction and can result in instructional design theories and models. Instructional design models employ instructional theories to prescribe types and levels of instructional support to optimize the achievement of identified learning goals.

Snow and Swanson (1992) suggested that the components of an instructional theory are "a) description of desired end states or goals of instruction in a domain; b) description of goal-relevant initial states of learners prior to instruction; c) explication of the transition processes from initial to desired states; d) specification of instructional conditions that promote this transition; e) assessment of performance and instructional effects." (p. 584) If we compare Gagné's instructional theory to these components we find that Gagné's theory does have these components. For example, Gagné describes potential **end goal states** in his categorization of learning capabilities. These goal states are generic in that they can apply across a variety of content areas. For each of the goal types Gagné described **goal-relevant initial states**, prerequisite relationship of intellectual skills and relationships of other types of learning. Gagné interpreted information processing theory to explicate the **transition processes** from initial to goal states for each type of learning. Gagné's greatest impact on instructional theory may be his thoroughness in specifying **instructional conditions** to support this transition process. He described these instructional conditions both as generalized events of instruction and as specific conditions of learning for each type of learning capability (Conditions of Learning, 1965, 1970, 1977, 1985) Finally, Gagné and his colleagues extended his thorough explication of learning outcomes into recommendations for **assessment** within each category (Gagné & Beard, 1978; Gagné, Briggs, & Wager, 1992).

Although Gagné was the first theorist to bring this elements together into an instructional theory, as with all learning/instructional theorists, his work was strongly influenced by the theorists who preceded him. To gain an adequate perspective of Gagné's influence on instructional theory, we must first survey the status of instructional theory prior to Gagné's influence.

Status of Instructional Theory Before Gagné

The need for instructional theory has long been recognized, and as early as 1899, William James pointed out that, as important as psychology is to education, it is not something from which the nature of the instruction may be directly induced: "You make a great, a very great mistake, if you think that psychology, being a science of the mind's laws, is something from which you can deduce definite programmes and schemes and methods of instruction for immediate schoolroom use" (James, 1899/1958. p. 23). Instructional theory remained an elusive topic before Gagné's contributions of the early 1960's. Two primary avenues of thought regarding instructional theory in the decade or so prior to Gagné's major contributions were a focus on: a) sequence and content concerns from within a curriculum theory frame of reference, and b) application of learning theory, particularly applications within a programmed instruction frame of reference.

Curriculum Theory. Much work that characterizes the status of instructional theory before Gagné is seen in the work of curriculum theorists. People such as Bruner and Tyler are among those whose work concentrated on matters of sequence and the content of learning. Bruner's (1960) concept of the spiral curriculum and Tyler's conception of the "rationale" for a course as its design beginning point (1950) are examples of curriculum thinkers' contributions to instructional thinking.

One persistent pattern in curriculum thinkers' approaches to instruction is to place primary emphasis upon teaching. Hosford (1973), for example, defined curriculum, instruction, and teaching much as an instructional systems specialist or instructional technologist might, but he insisted on placing teaching at the center of his conception of instruction and, in subsequent treatment of a theory of instruction, made the continued assumption that teaching and teachers would be the primary (or only) means of implementation. Such a focus on teaching, it appears, prevents curriculum theorists from thinking vigorously and directly about instruction itself. Nonetheless, for better or worse, the more philosophical contributions from curriculum thinkers formed a substantial proportion of instructional theory.

Bruner's widely recognized work in instructional theory (1968) proposed four criteria that an instructional theory should meet. An adequate theory of instruction, according to Bruner, would provide the basis for specification of: a) experiences which will induce motivation to learn, b) optimal structures of knowledge for learning, c) optimal sequences of encounter; and d) the nature and pacing of rewards and punishments. In many regards Bruner's widely heralded work seems now naive and quaint. His concentration on structures of knowledge within disciplines at the expense of treatment of form of encounter and his treatment of intrinsic motivation within a category labeled "rewards and punishments" are reflections of a teaching-centered view of instruction.

In a less widely recognized but at least equally valuable contemporary work to Bruner's, Gordon (1968) presented a relatively mature view of instruction and instructional theory. Gordon defined a theory of instruction as "a set of statements, based on replicable research, which would permit one to predict how particular changes in the educational environment (classroom setting) would affect pupil learning." (p. 3) Gordon differentiated the terms "instruction" and "teaching" by noting that teaching "refers primarily to the human interaction between teacher and pupil" (p. 3) and instruction as the more encompassing term, referring to "the activity which takes place during instruction and within the classroom setting. The term includes both material and human variables." (p. 3). The distinctions that Gordon made between instruction and teaching are useful ones, as the study of instruction and the study of teaching are reflected separate bodies of literature as well as distinct traditions of interest and inquiry. However, reflecting the curriculum and teaching methods orientation, Gordon restricted his conception of instruction to classroom activities, a restriction that might be viewed as limiting by current instructional theorists.

Before Gagné's work had become widely recognized (and, of course, remaining conventional in many Education specialties today) many authorities believed that the most important instructional considerations lay within the structures of subject matter disciplines and the interface of those structures with broad developmental characteristics of learners. The structures of knowledge within the various disciplines--science, mathematics, history, and so on--was (and is) seen to vary radically from discipline to discipline in conceptual, syntactical, and substantive ways (Ford & Pugno, 1964; Phi Delta Kappa, 1964). Gagné brought a sufficiency of scholarship to questions of learning from instruction that arise from the psychological requirements of learning tasks, as opposed to questions which arise from parent disciplines from which subject matter comes, to yield prescriptive principles which--though not universally adopted in educational theory have had a substantial impact upon theory and research that have examined educational practice.

Applied Learning Theory. Although typically involving itself with animal conditioning experiments, the mainstreams of learning psychology in the first half of the twentieth century, exemplified by Guthrie, Skinner, and Hull, were deeply concerned with human learning. Guthrie's association-centered theory (Guthrie, 1935, 1942) gave rise to Sheffield's (1961) work in learning complex sequential tasks and Lumsdaine's (1961) training research on effects of cueing. Skinner's operant conditioning saw application by Skinner (1954) and Holland (1960). Hull's detailed, systematic, and quantified approach to learning based on drive-reduction led to instructionally-relevant research on feedback by Miller and Dollard (1941).

Clearly, learning theory was in disarray when Hilgard wrote the concluding chapter to Theories of Learning (Hilgard, 1948): "We need a more careful delineation of the kinds of learning which take place.... This search for the appropriate concepts is not merely an exercise in definition or classification. It requires a high order of theory construction, based on open-minded acceptance of demonstrable relationships." (p. 326-327) Almost 30 years later, the concluding chapter in the fourth edition of that work (Hilgard & Bower, 1978) was entitled "Instructional Theory." The first reference cited in that chapter is the first review of instructional psychology in Annual Reviews by Gagné and Rohwer (1969). Hilgard and Bower described Gagné's work to that time as one of three models that provide "indications

of what is to come." (1978, p. 614). In addition to Gagné's "hierarchical theory," Bruner's "cognitive-developmental theory" and Atkinson's "decision-theoretic analysis for optimizing learning" are described. Of these, although important subsequent work was done by all three, Gagné appears to have gone the furthest toward development of a full instructional theory.

A great deal of interest in the 1950's was generated by the innovation called "programmed instruction." Embodied in both teaching-machine and text-based forms, programmed instruction carried with it ideas of far greater importance than the competing specific forms and rules dictating format that were matters of heated debate at the time. With programmed instruction, an agency other than a person was seen as an instrument of instruction. Previously, all non-human tools including books, television, and the various forms of audiovisual media, were conceptualized as aids or resources for a teacher's use. Even the powerful medium of motion pictures (and later television) was viewed as something that had "classroom" uses, which required a teacher's introduction and follow-up for meaningful learning to anticipated.

This radical change in view of the potential of instructional media brought with it a radical change in what might be studied as "instruction" and how research on it might be conducted. In his landmark review, "Instruments and Media of Instruction," Lumsdaine (1963) pointed out the significance of the ideas behind programmed instruction for thinking about research on instruction: "...the control of learner behavior and feedback which is provided by the continuous record of student response from auto-instructional programs may afford the most promising vehicle yet developed for the analytic experimental student of variables affecting human learning (as well as for the incorporation of research findings in improved instruments)." (Lumsdaine, 1963, p. 608) Research on programmed instruction brought with it, perhaps unknowingly but certainly inevitably, focused concern on matters of form of encounter with material to be learned outside the frame of reference of "teaching." As teaching itself is not a reproducible event, the study of teaching has focused on matters that can be of ultimate utility in understanding the role of teachers, understanding the teaching act, and understanding interactions among teachers, learners, and activities. When studying instruction using agencies providing sequenced and reproducible events, controlled investigations of form of encounter became practicable. An enormous corpus of research was developed during the 1950's and 1960's under the programmed instruction umbrella on areas such as practice, feedback, sequence, and criterion-referenced assessment.

One example of how work in programmed instruction contributed to instructional theory can be seen in "validation" procedures for programmed instruction. The first work in what would now be labeled "formative evaluation" was developed under the notion of "how should programmed instruction be validated?" Procedures for the development and establishment of known quality in programmed instruction materials have evolved over the years to include instruction in any form and are the basis of current formative evaluation principles and procedures. Other examples can be seen in studies on such areas as instructional feedback, instructional event sequencing, pacing, optimal prompting of practice, and forms of practice and response.

Other cornerstones of contemporary instructional design practice, such as use of performance objectives, have their roots in programmed instruction. However, the generalization which transpired between thinking of "how to best implement a particular programmed instruction format" on the one hand and "how to optimally conduct instruction" on the other, is not a trivial one. Gradually attention began to shift from the procedural details to variables, questions, and models of instruction that would underlie the techniques. No one contributed more to this shift in thinking--much of his own work in the 1950's and early 1960's can be seen as an embodiment of it--than Robert Gagné.

Precursors to Instructional Theory

Of the schools of thought that underlie instructional theory, Gagné clearly comes from the "applied science" perspective. As a psychologist, he studied learning in demanding, realistic settings, and was, in fact, somewhat impatient with colleagues whose purity of purpose prevented their doing the more messy and often less clear applied research that instructional theory-building requires. In a review of factors that contribute to learning efficiency for a volume on programmed instruction sponsored by the Air Force Office of Scientific Research, Gagné and Bolles noted that "the learning tasks that have been most intensively studied by psychologists have been of an artificial "laboratory" variety; relatively little is known about learning in real life situations." (Gagné & Bolles, 1959, 13-14)

Training research in the 1950's put Gagné in touch with a wide variety of instructional problems, representing a wide variety of learning tasks. Illustrative studies in the literature are Gagné (1954) "An Analysis of Two Problem Solving Activities" involving troubleshooting and interpretation of aerial photographs, and Gagné, Baker, & Wylie (1951) "Effects of an Interfering Task on the Learning of a Complex Motor Skill" involving manipulations of controls similar to aircraft controls. In a review of problem-solving and thinking, Gagné pointed out the relevance of trouble shooting studies to issues in concept formation (Gagné, 1959). Wide and vigorous participation in research on learning and instruction in the military environment, along with his thorough and rigorous background as a learning psychologist, may have created the dissonance that motivated Gagné to develop the concepts of conditions of learning, learning hierarchies, events of instruction, and types of learning. In the following pages, we will discuss each of these three contributions to instructional theory.

Instructional Theory Contributions

Gagné developed four major propositions that constitute his instructional theory:

a) Learning goals can be categorized as to learning outcome or knowledge type;
b) Acquisition of different outcome categories requires different internal processes;
c) Learning outcomes can be represented in a predictable prerequisite relationship;
d) Acquisition of different outcome categories requires identifiably different instructional processes.

Development of Types of Learning. Gagné was, of course, not the first theorist to suggest that all learning is not alike, that learning might be analyzed into different types of learning. Indeed, as early as 1933 Carr suggested classes of experimental learning tasks and warned that principles that had been derived about one set of tasks could not necessarily be generalized to other classes (Melton, 1964). In the 1940's scientists such as Melton (1941) and Tolman (1949) continued the efforts to categorize learning types. During an informal meeting of college examiners at the 1948 American Psychological Association conference, Bloom and his colleagues discussed the need for a set of common descriptors of learning to facilitate communication among them. This effort resulted in "Bloom's Taxonomy" of cognitive educational objectives (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) and Krathwohl's taxonomy of affective educational objectives (Krathwohl, Bloom, & Masia, 1964). Despite the original intention of these taxonomies to standardize terminology, they readily assumed the stature of psychologically-based correlates.

In 1962, Melton organized a "Symposium on the Psychology of Human Learning" that was held at the University of Michigan at Ann Arbor. The focus of the symposium was to discuss "the interrelationship of different categories of human learning." (p. vii) Melton later edited a book Categories of Human Learning (1964) that compiled many of the papers from this symposium. Among these was Robert Gagné's chapter "Problem Solving." In this chapter Gagné presented a table entitled "A Suggested Ordering of the Types of Human Learning" in which he proposed the following six types of learning: Response learning, chaining, verbal learning (paired-associates), concept learning, principle learning, problem solving (Gagné, 1964, p. 312). Gagné did not cite a previous publication related to these concepts, so this chapter may be the first appearance of his types of learning outcomes categories. In this chapter he began to differentiate between verbal learning and "nonreproductive" types of learning, such as concept learning and problem solving. This differentiation eventually led to his separate domains of learning of "verbal learning" and "intellectual skills."

Gagné presented the first complete statement of the types of learning conception in his first edition of The Conditions of Learning (Gagné; 1965). He began by reviewing learning theory and research, such as James, Dewey, Watson, Thorndike, Tolman, Ebbinghaus, Pavlov, and Köhler, introducing the idea of types of learning, with the notion of "learning prototypes,"

> Throughout the period of scientific investigation of learning there has been frequent recourse to certain typical experimental situations to serve as prototypes for learning. . . . These learning prototypes all have a similar history in this respect: each of them started to be a representative of a particular variety of learning situation. Thorndike wanted to study animal association. Pavlov was studying reflexes. Ebbinghaus studied the memorization of verbal lists. Köhler was studying the solving of problems by animals. By some peculiar semantic process, these examples became prototypes of learning, and thus were considered to represent the domain of learning as a whole, or at least in large part. (p. 18-19)

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Gagné (1965) presented eight types of learning in the first edition, in a rather strict hierarchical relationship. He described all types but the first, signal learning (classical conditioning), as having prerequisite relationships with one another. Gagné carefully referenced researchers that had examined these eight types of learning:

1. Signal learning (Pavlov, 1927)
2. Stimulus-Response learning (Thorndike, 1989; Skinner, 1938; Kimble, 1961)
3. Chaining (Skinner, 1938; Gilbert, 1962)
4. Verbal Association (Underwood, 1964)
5. Multiple Discrimination (Postman, 1961)
6. Concept Learning (Kendler, 1964)
7. Principle Learning (Gagné, 1964)
8. Problem Solving (Katona, 1940; Maier, 1930) (pp. 58-59)

This list remained relatively unchanged in the second edition of Conditions of Learning (1970). By the third edition (Gagné, 1977), Gagné added information processing theories to the treatment of learning prototypes, recasting the types of learning to some degree by their different cognitive demands . In addition, an increasing influence of task characteristics, rather than psychological processes guided the form and content of the types of learning. In its latest form as of this writing (Fourth Edition, Gagné, 1985), he identified distinctly different categories within the domain of intellectual skills: discriminations, concepts, rules, and higher-order rules (domain-specific problem-solving). He proposed that these knowledge types are in a prerequisite, vertical transfer relationship, with discriminations prerequisite to concepts, concepts, prerequisite to rules, and rules prerequisite to problem solving. The types of learning in the fourth edition are:

1. Intellectual Skills
   - discriminations
   - concepts
   - rules
   - problem solving
2. Cognitive Strategies
3. Verbal Information
4. Motor Skills
5. Attitudes

(Gagné later pointed out that the verbal information category could also be termed "declarative knowledge" and the intellectual skills category could be termed "procedural knowledge.")

More recently, Gagné and Merrill (1990) identified another category, which they termed "enterprise." They described this category as being substantively different from the other learning outcomes that Gagné or Merrill had previously identified, requiring the integration of the other more simple learning outcomes, such as rules, concepts, and declarative knowledge.

There are two ways in which one might view these outcomes: as descriptions of tasks (with external, "task-related" differences) or are they descriptions of learned abilities (with differences arising out of distinctive processing or memory structures)? Gagné has tended to define these outcomes as the latter, describing them as "learned dispositions," "capabilities," or "long term memory states," (1985, p. 245). He described verbal information and intellectual skills as having distinctly different memory storage systems, consistent with those of other theorists, such as Anderson (1990). An empirical basis for the "verbal information" knowledge to be stored as propositional networks is provided by Gagné and White (1978). Rule-using is described by Gagné and White as stored in hierarchical skill structures which they referred to as "intellectual skills." Verbal information has been described more recently by Gagné (1985) as being stored as propositional networks or schemata. He described rules, including concepts (defining rules), as being stored as "if.. then" productions. The storage of problem solving capabilities themselves was not addressed, although interconnections

of schemata and productions were implied. The storage mechanisms of attitudes, motor skills, or cognitive strategies are also not explicitly discussed.

Gagné's categorization of learning outcomes has not been without it critics. Although Gagné characterized his categorization system as more internally, than externally derived, Kyllonen and Schute (1989) viewed Gagné's categorization of learning types as a "rational taxonomy," developed via proposing "task categories in terms of characteristics that will foster or inhibit learned performance." (p. 120) They suggested that the limitation of such categories is that their basis is not psychological processes and, therefore, such processes are unsystematically considered.

Development of the Learning Hierarchies Concept. Perhaps as significant as his delineation of categories of learning, is Gagné's conception of a learning hierarchy. Although this hierarchical relationship was implied in the taxonomies of a number of theorists (Cotterman, 1959; Demaree, 1961; Lumsdaine, 1960; Miller, 1962; Parker & Downs, 1961; Stolurow, 1964; Willis and Patterson, 1961), it was Gagné who brought the conception of "learning hierarchy" clearly into focus with his statements regarding the nature of these relationships and his research to validate these principles.

Gagné's first references to "learning hierarchies" appears in articles published in 1962, a report of a study, "Factors in Acquiring Knowledge of a Mathematical Task" (Gagné, Mayor, Garstens, and Paradise, 1962) and another study, "The Acquisition of Knowledge," (Gagné, 1962) which involved similar learning tasks. These reports were preceded by a Gagné and Paradise's 1961 study, which formed a foundation for the latter studies. In 1961, Gagné and Paradise found support for the proposition that transfer of learning from subordinate sets of learning tasks could account for performance in a terminal learning task. In a subsequent study, Gagné, Mayor, Garstens, and Paradise (1962) sought to extend and confirm the validity of the idea of the "learning hierarchy." In this study, the posttest supplied information about achievement of not only the terminal task (adding integers) but also the 12 prerequisite learning sets, each scored as "pass" or "fail." Success in final task achievement correlated highly with the number of subordinate tasks successfully achieved for both of the two terminal learning tasks (.87 and .88). Patterns of transfer among the subordinate tasks also conformed to theoretical predictions of a learning hierarchy.

In 1973, Gagné fully described learning hierarchies as having the following characteristics: They a) describe "successively achievable intellectual skills, each of which is stated as a performance class; " b) do not include "verbal information, cognitive strategies, motivational factors, or performance sets;" and c) describe "only those prerequisite skills that must be recalled at the moment of learning" to supply the necessary "internal" component of the total learning situation. (p. 21-22)

White (1973) reviewed a number of studies that attempted to validate learning hierarchies developed according to Gagné's principles. He found none that had a perfect match with predicted prerequisite relationships. However, he suggested that many of the studies were seriously flawed by imprecise specification of prerequisite tasks, using only one item per prerequisite task, small sample sizes, and other methodological problems. Research has continued both on methodologies to validate hierarchies and techniques for specifying hierarchies (e.g., Airasian & Bart, 1975; Cotton, Gallagher, & Marshall, 1977; Griffins, 1983; Kee & White, 1979; Wilson, 1989; Winkles, 1986). For example, Winkles (1986) investigated the learning of trigonometry skills with a learning hierarchy validation study, identifying both lateral and vertical transfer. Two experiments with eighth and ninth-grade students involved instructional treatments described as "achievement with understanding" and "achievement only." Results reported "achievement with understanding treatment is better for the development of lateral transfer for most students, and of vertical transfer for the more mathematically able students, whereas the differences between the treatment groups on tests of achievement and retention of taught skills are not significant. A small amount of additional instruction on vertical transfer items produces much better performance under both treatments." (p. 275)

Development of Events of Instruction. In 1962, in addition to presenting the "learning hierarchies" concept, Gagné also introduced began to consider features that should be included in the instructional situation, such as description of the required terminal performance and provision of "guidance of thinking." Then, in the first edition of The Conditions of Learning (1965) Gagné included a section headed "component functions of the instructional situation"

which, except for its label, is basically identical to the "events of instruction" seen in later editions of The Conditions of Learning. The eight functions were a) presenting the stimulus, b) directing attention and other learner activities, c) providing a model for terminal performance, d) furnishing external prompts, e) guiding the direction of thinking, f) inducing transfer of knowledge, g) assessing learning attainments, and h) providing feedback. In the second edition of The Conditions of Learning (Gagné, 1970), Gagné added "The Events of Instruction" to a new chapter entitled "The Design of Instruction," completing the development of the fundamental concept of "the events of instruction."

Although researchers have expended much effort in investigating the optimal nature of individual events (e.g., feedback research, research on objectives), the validity of events of instruction as a whole have not been subjected to much research. This must in part be due to Gagné's assertion that instruction must not necessarily include all events on all occasions, as learners are often able to supply the processing that the events evoke without external prompting. The authors did, however, find one study that examined the effectiveness of the events in instruction for high school students on the use of quotation marks (Coats, 1985). The experimental study involved three treatments: a) all nine events; b) only four events: presenting stimulus materials, providing learning guidance, eliciting performance and providing feedback, and c) the same events as in treatment b with more elaborate eliciting performance and feedback events. The results indicated no main effects for treatments, but an interaction between ability and treatment: High ability learners performed better under treatment b; low ability learners under treatment c. It is really no surprise that by high school the students did not need much introduction to quotation marks, that are represented by the early events of instruction. Nor is it a surprise that the low ability learners performed better under a condition that required more practice and feedback.

Conditions of Learning. Perhaps more than the explication of categories of learning capabilities and the events of instruction, Gagné's major contribution to instructional theory lies in his suggestion that for each category or subcategory of learning capability to be acquired, certain internal conditions must be met. His attention to the conditions within the learner has been long-lasting, as he has conjectured about necessary conditions within the learner since his first edition of Conditions of Learning (1965). He further suggested from this first edition that these internal conditions vary somewhat by learning capability. Specifically, he has proposed in more recent years that the internal events that may differ most across learning capabilities are "a) substantive type of relevant prior knowledge, b) manner of encoding into long term storage, c) requirement for retrieval and transfer to new situations." (1984, p. 514) It should be noted that in Gagné's detailing of the internal conditions of each type of learning, the major internal condition that he details is prerequisite knowledge. Gagné used an information-processing model including processes of attention, selective perception, semantic encoding, retrieval, response organization, control processes, and expectancies to contextualize these cognitive processes.

He, therefore, in his 1985 edition of Conditions of Learning pointed out that the events that may differ most significantly from learning category to learning category are those corresponding to the above three internal events: These external events are a) stimulating recall of prior knowledge, b) providing learning guidance, and c) enhancing retention and transfer.

As an instructional psychologist, Gagné was particularly interested in the external conditions that might occur or could be provided to "activate and support" the internal processing necessary for learning to occur (1985, p. 276). In fact, Gagné defined the purpose of instructional theory as "to propose a rationally based relationship between instructional events, their effects on learning processes, and the learning outcomes that are produced as a result of these processes." (1985, p. 244) Therefore, Gagné derived the external events from the internal events of information processing.

Gagné particularized the general external events, the "events of instruction," that begin to be described in his work in 1962 to specific prescriptions for external conditions for each type of learning, event by event, for each of the categories of learned capability. Much of these external conditions is logically derived from the intersection of the function of the external event (those cognitive processes that it supports) and the nature of the learning capability. He labeled these external supports for each type of learning as their "(external) conditions of learning."

Gagné and Glaser (1987) included an excellent summary of hypothesized differential learning conditions for types of learning.

Table 7-1. Gagné and Glasser's Learning Categories X Conditions Summary

Type of Capability	Effective learning conditions for categories of learned capabilities Learning Conditions
Intellectual skill	Retrieval of subordinate (component) skills Guidance by verbal or other means Demonstration of applic. by student; precise feedback Spaced reviews
Verbal information	Retrieval of context of meaningful information Performance of reconstructing new knowledge; feedback
Cognitive strategy (problem solving)	Retrieval of relevant rules & concepts Successive presentation (usually over extended time) of novel problem situations Demonstration of solution by student
Attitude	Retrieval of information and intell. skills relevant to targeted personal actions Establishment or recall of respect for human model Reinforcement for personal action either by successful direct experience or vicariously by observation of espected person
Motor Skill	Retrieval of component motor chains Establishment or recall of executive sub-routines Practice of total skill; precise feedback.

(Gagné & Glaser, 1987, p. 64)

Unfortunately, there has not been systematic research investigating the validity of the principles for external conditions for specific types of instruction as suggested by Gagné. However, there are some lines of research that have suggested that his underlying premise that different types of learning are facilitated by different instructional conditions. For example, a meta-analysis by Schimmel (1983) suggested that feedback may be more potent for intellectual skills objectives than for verbal information objectives. In addition, Schimmel found that confirmation feedback was more useful than correct answer feedback for verbal information outcomes. However, he did not find this superiority of confirmation feedback for intellectual skills objectives. Research on the value of providing learners with objectives reveals another example of research that may support Gagné's principles of conditions of learning. Hartley and Davies (1976) found that providing objectives benefited students when the learning task is an intellectual skill, but was not significantly beneficial to promote verbal information learning. Although these findings are in no way comprehensive, they do provide some validation of an outcomes by conditions theory of instruction.

The Relationship of Gagné's Work to Learning Theory

Gagné's work is not easily related to a single learning theory base. His early work, frequently characterized as behaviorist, might better be considered more broadly as associationist. Within the associationist tradition, his work appears to fit better within the functionalist group than either the behaviorist or connectionist. However, the integrative nature of his work, particularly as reflected in the first edition of Conditions of Learning, transcended the traditional categories of learning theory. An examination of the sources for the eight categories of learning identified in this first edition reveals origins in field theory (from gestalt psychology) as well as functionalism and behaviorism. The range of

learning types that he wished to consider were not adequately examined under any single theory at that time, so he had to examine a number of learning theories in order to develop his instructional theory.

Certainly, by the first edition of Conditions of Learning (1965), Gagné was beginning to conjecture about the internal conditions of the learner. And, by the second edition, he used an information processing model (although it is not labeled as such) to describe the cognitive processes that occur during a "learning sequence." (1970, pp. 70-71) In the third edition of Conditions of Learning (1977), Gagné's instructional theory was thoroughly integrated with information processing theory. Although he employed other theories, as appropriate. Gagné has continued to draw substantially from information processing theory, one of the family of cognitive learning theories, as his basis for describing the internal processes and structures of learning that are affected by the external conditions and events of instruction.

One frequently finds Gagné's work described as behaviorist, associationist, as well as cognitivist. Indeed, it is difficult to utilize a single learning theory with which to characterize his work. An attribute of Gagné's theory that makes it so difficult to accurately categorize is that although his theory base was eclectic in source it was unified in result. Hilgard and Bower pointed out that Gagné's work "is not strictly an eclectic theory (which chooses good principles from here and there without any order among them), but is the beginning of a unified theory." (1966, p. 569). And that result, an instructional theory, even in its earliest versions is not well-classified as behaviorist or even associationist psychology. Gagné's theory as reflected in later editions of Conditions of Learning moved even further from the associationist perspective and became increasingly based on cognitive psychology, with an information processing emphasis. Perhaps the source of the difficulty in classifying Gagné's theory arises from attempts to classify it under the categorization system of learning theories, when it is in effect an instructional theory that proposes facilitating instructional conditions for a range of learning types from declarative knowledge to psychomotor skills to attitudes. No single learning theory at this time appears to adequately explain or predict all of these types of learning. Hence, an eclectic learning theory base for Gagné's instructional theory is entirely appropriate.

Influences of Gagné's Theory on Instructional Design Models

Gagné's theory has been foundational in providing the basis of what can be termed "conditions-based" models of instructional design. Conditions-based models are predicated upon the propositions that (a) learning can be classified into categories that require similar cognitive processes for learning ("internal conditions of learning") and, therefore, (b) within these categories of learning similar instructional supports are needed to facilitate learning ("external conditions of learning"). Conditions-based models of design which are derivative of Gagné's work include those by Merrill (1983), Reigeluth (1979), Merrill, Li, and Jones (1990a & b), and Smith and Ragan (1993).

In the early 1970's, M.D. Merrill developed a conditions-based model for instructional design called "component display theory." Merrill noted that component display theory evolved from his interactions with students studying Gagné and that "CDT is founded on the same assumption as Gagné's work--namely that there are different categories of outcomes and that each of these categories requires a different procedure for assessing achievement and a different procedure for promoting the capability represented by the category." (Merrill, 1983, p. 284-285) Early work describing most of the elements of CDT appears in Merrill and Boutwell (1973). CDT classifies objectives in a two-dimensional matrix made up of three performance levels and four content types. This 12-category system differs from Gagné's in that instead of having a declarative knowledge category, as Gagné does, which would include remembering facts, concept definitions, rule statements, and procedural steps, CDT provides separate categories for each of these types of declarative knowledge. And, instead of having a single category for cognitive strategies, as Gagné does, CDT proposes "find" operations for each of the content types: Find a fact, find a concept, find a rule, and find a procedure. CDT also includes a treatment of external conditions for learning as "presentation forms," including content (generality or instance), and approach (expository or inquisitory) as primary forms and, for secondary presentation forms, elaborations such as context, prerequisite, mnemonic, mathemagenic help, representation or alternative representation, and feedback. The idea of presentation forms relating to different categories of learning appears to be an elaboration of Gagné's conceptions of external conditions for learning.

Pinning down differences and similarities between Merrill's CDT and Gagné's types of learning represents something of a moving target because both systems have changed over the years. For example, Gagné's "types of learning" evolved into a very different form from that which was presented in 1965. In general, the types of learning

evolved to keep up with changing knowledge about learning and cognition as well as different ideas about learning from instruction which were being developed by contemporaries. We can speculate that some of the impetus for change in Gagné's types of learning during the 1970's may have come from ideas such as Merrill's component-display theory.

C.M. Reigeluth developed a model for instructional design, "the "elaboration theory," during the late 1970's (Reigeluth, 1979). As an extension of Merrill's component display theory, elaboration theory may be seen as a "grandchild" of Gagné's seminal work. Elaboration theory takes a broader view than CDT and provides guidance for the design of instruction for complex, unfamiliar, multi-topic content rather than prescribing the form of encounter for individual lessons. The conditions-based nature of the model is seen in Reigeluth's specification of three differing structures, conceptual, procedural, or theoretical, which are selected based upon the goals of the course. Later development by Reigeluth includes the "simplifying conditions model" which retains a conditions-based orientation by suggesting that different simplifying conditions structures need to be developed for each of the kinds of knowledge structures described (Reigeluth & Rogers, 1980; Reigeluth, 1992).

In part an extension of CDT, Merrill and associates have formulated a model for instructional design ,which also has links to Gagné's work, entitled "ID^2" - a "second-generation" instructional design model (Merrill, Li, and Jones,1990a, 1990b). In large measure, ID^2 was developed to assist in the development of an expert system for instructional design, "ID Expert." ID^2 vigorously extends the basic conditions model, making more explicit the theorized relationship between learning outcomes and internal/external conditions of learning:

> a) A given learned performance results from a given organized and elaborated cognitive structure, which we will call a mental model. Different learning outcomes require different types of mental models; b) the construction of a mental model by a learner is facilitated by instruction that explicitly organizes and elaborates the knowledge being taught, during the instruction; c) there are different organizations and elaborations of knowledge required to promote different learning outcomes. (Merrill, Li, & Jones, 1990b, p. 8)

Smith and Ragan (1993) developed an approach to the design of instruction that exemplifies and elaborates Gagné's theory. Using Gagné's types of learning, they postulated a generalized cognitive process necessary for the acquisition of each of the different learning capabilities, thereby deriving a system of instructional strategy recommendations for different types of learning. Smith and Ragan also suggested that the events of instruction as Gagné portrayed them insufficiently considered learner-generated and learner-initiated learning, and restated the events so that they could readily be perceived as either learner-supplied, in the form of learning strategies, or instruction-supported, in the form of instructional strategies.

Smith and Ragan have proposed a model–Comparison of Generative/ Supplantive Strategy (COGSS)– for determining the balance between instructional strategies (instruction-supplied events) and learning strategies (learner-supplied events) based upon context, learner, and task variables. They also proposed that there is a "middle ground" between instruction supplied, supplantive (also know as "mathemagenic") events and learner-initiated events, in which the instruction facilitates or prompts the learner to provide the cognitive processing necessary to an instructional event.

Gagné's instructional theory has spawned at least two generations of instructional design theories that have concretized, elaborated, and exemplified Gagné's conditions-based propositions. However, his influence has extended beyond instructional design theory into other areas of educational design, including curriculum design.

Influences of Gagné's Theory on Curriculum Design

Although Gagné's work was directed at the study of instruction, not at teaching or curriculum, a substantial influence from his ideas can be observed in those fields. Sometimes harboring conceptions fundamentally hostile to ideas grounded in learning theory, the curriculum and teaching methods traditions represent a "tough audience" for Gagné. However, as early as 1966 W.B. Ragan, a curriculum theorist whose Modern Elementary Curriculum was an influential text for more than 25 years, made extensive use Gagné's ideas in its explanation of learning. A survey of more recent curriculum texts found some evidence of impact of Gagné's ideas, such as the importance of consideration of types of learning when determining an instructional approach. For example, Pratt (1980) prescribed the matching of instruction with objectives, classifying objectives as knowledge, skills, physical development, dispositions, and experiences. With

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the exception of "experiences," Pratt's categories of objectives are a close fit to Gagné's types of learning. Indeed, in Pratt's chapter describing these objective categories, he cited Gagné and provided information on intellectual skills from Gagné and Briggs (1979). The basic approach that Pratt recommended, deriving plans for the form of instruction from (among other sources) the different demands placed on learners in achieving different sorts of objectives, is a solid application of Gagné's thinking.

Posner and Rudnitsky (1994) proposed a learning task categorization scheme very similar to Gagné's: Employing understandings (cognitive and affective), and skills (cognitive skills, psychomotor-perceptual skills, affective skills). They cited Gagné as one of the sources of their categorization scheme. In another text, Robinson, Ross, and White (1985) identified different "growth schemes" for different types of learning: inquiry skills, knowledge outcomes, affective outcomes. This idea of tying different educational experiences to different types of learning is very much in the Gagné tradition.

Too often, unfortunately, curriculum theorists badly misinterpret Gagné's ideas or represent early work as if it reflects his current thinking. In citing a 1967 definition of curriculum offered by Gagné, Tanner and Tanner (1980) noted that Gagné's definition "assumes that learning is mechanical and linear, and that the learner is a mere mechanism to be conditioned toward making the right automatic responses." (p. 26). The quote to which Tanner and Tanner are responding , is within a discussion of cumulative learning effect from mastery of prerequisite learnings, "curriculum is a sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act, provided that the capabilities described a specified prior units (in the sequence) have already been mastered by the learner." (Gagné, 1967, p. 23). Perhaps in retribution for such a simplistic definition of curriculum, Tanner and Tanner provided a characterization of Gagné's approach as being based on conditioning and "right responses." This interpretation is totally inaccurate. In addition, it is dismaying that in writing a 1980 text that the authors chose to refer to a 1967 publication of Gagné's work, rather than to refer to the most recent edition of Conditions of Learning (1977) that would have more accurately reflected Gagné's position at the time.[1]

In a more friendly discussion, but still inappropriate classification, Gagné's work was characterized as "social behaviorist" by Schubert (1986). The research methodology works of Campbell and Stanley (1966) and Kerlinger (1973) were also placed in this category, so use of the term "behaviorist" is apparently an original one, referring essentially to any "scientific" approach to education. Schubert's discussions of Gagné's work are not trivializing, however, and represent a thoughtful and informed application from a curriculum perspective.

Conclusion

As described in the discussions of Gagné's major theoretical contributions, Gagné has developed, refined, and extended his theory over time. This continuing development based upon new theory and research, distinguishes him among scholars in educational/instructional psychology. His instructional theory fulfills many of Snow and Swanson's criteria that were presented at the beginning of this chapter as components of an instructional theory

a) description of desired end states or goals of instruction -- Gagné's types of learning;

b) description of goal-relevant initial learner states -- Gagné's prerequisite analysis via learning hierarchies;

c) description of the transition processes -- Gagné's internal conditions of learning;

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[1] The propensity to cite "intellectually dated," rather than available and more recent work that would more accurately represent the current development of Gagné's theory is distressingly common in not just the curriculum theory literature, but in many sources that cite his work. Another example of such a problem is found in Bower and Hilgard's learning theory text (1981), which states that Gagné is (note present tense) an associationist and cites a 1970 edition of Conditions of Learning. In some cases these statements and dated citations may be results of simple oversights, sloppy scholarship. In other cases they appear to be intentional in order to misrepresent Gagné's work and position. Such distortions are reprehensible and violate the very core of what constitutes "good scholarship." These misrepresentations are made all the more unjust by their targeting the work of a scholar who has for many been the very personification of a "life-long scholar." His work has developed continually throughout his professional life as he examined his position and responded with thoughtful revisions of his ideas. He has also been meticulous in *his* citation of the work of others. In addition, such misrepresentation has created no end of difficulty for those in our field, as communication with colleagues and students who have read such misrepresentations can be difficult, time-consuming, and even embarrassing to some who are involved.

d) detailing of instructional conditions that promote this transition -- Gagné's external conditions of learning;
e) assessment of performance and instructional effects -- Gagné and Briggs explication of appropriate assessment technology.

Gagné has left some questions for future researchers and theorists to work out. One of these areas is in the description of the transition processes between novice and experts. Gagné has carefully defined some of these internal conditions, particularly prerequisite knowledge states. It is left to others to delineate these processes more completely for the various learning types through careful empirical validation. A second area is the clear explication of the relationships between required internal processes and external conditions of learning. Within this study may be the examination of necessary versus sufficient conditions to support internal processing. A third area of extension might be a further examination of the relationship between declarative knowledge and intellectual skills. There appears to be ample evidence to support the conclusion that the ability to state the generalities underlying intellectual skills is not prerequisite to the learning of intellectual skills. However, it is still unclear whether some other aspect of the declarative nature of intellectual skills might be prerequisite. A test of the robustness of a theory is not only the number of questions it answers, but also the number of questions is spawns. Gagné's instructional theory is fertile with substance to be examined by future scholars.

It is difficult to overestimate the impact R.M. Gagné has had on instructional theory. Although his has not been the only important voice in shaping the field, it has been an enormously influential one by virtue of the prodigious volume of original work which is at once bold in its conceptions and careful in scholarship. This combination of thoroughly grounded yet vigorously inventive work has left a legacy for a field of study to build upon.

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